

AMENDMENTS TO THE CLAIMS

1. (Currently amended) A pixel cell comprising:

a photosensor having a first doped region and a second doped region in association with a semiconductor substrate;

an isolation region formed within said substrate and adjacent to said photosensor; and

a halogen-rich region localized at least at a sidewall region and a bottom portion of said isolation region.

2. (Original) The pixel cell of claim 1, wherein said halogen-rich region is between said isolation region and said photosensor.

3. (Original) The pixel cell of claim 1, wherein said halogen-rich region is formed with an ion selected from the group consisting of fluorine, chlorine, bromine, iodine, and any combination of fluorine, chlorine, bromine, and iodine.

4. (Original) The pixel cell of claim 1, wherein said halogen-rich region and said first doped region of said photosensor overlap.

5. (Previously presented) The pixel cell of claim 1, wherein said halogen-rich region has a peak ion concentration at a depth of about 300Å to about 800Å from a surface of said substrate.

6. (Original) The pixel cell of claim 1, wherein said halogen-rich region has a concentration of halogen ions from about $5 \times 10^{13}/\text{cm}^3$ to about $5 \times 10^{15}/\text{cm}^3$.

7. (Previously presented) The pixel cell of claim 1, further comprising a charge collection region for receiving charges from said photosensor, said charge collection region being electrically connected to readout circuitry.

8. (Original) The pixel cell of claim 7, further comprising a transfer transistor formed between and connecting said photosensor and said charge collection region.

9. (Withdrawn) An integrated circuit comprising:
an array of pixel cells, at least one pixel cell of said array comprising:
a semiconductor substrate having an isolation region formed therein;
a photosensor having a first doped region and a second doped region in association with said semiconductor substrate;
a halogen-rich region below said isolation region and between said photosensor and said isolation region; and
signal processing circuitry formed in said semiconductor substrate and electrically connected to said array for receiving and processing pixel signals representing an image acquired by said array and for providing output data representing said image.

10. (Withdrawn) The integrated circuit of claim 9, wherein said halogen-rich region is formed with an ion selected from the group consisting of fluorine, chlorine, bromine, iodine, and any combination of fluorine, chlorine, bromine, and iodine.

11. (Withdrawn) The integrated circuit of claim 9, wherein said halogen-rich region has a depth from a surface of said semiconductor substrate of about 300Å to about 800Å.

12. (Withdrawn) The integrated circuit of claim 9, wherein said halogen-rich region has a concentration of halogen from about $5 \times 10^{13}/\text{cm}^3$ to about $5 \times 10^{15}/\text{cm}^3$.

13. (Withdrawn) The integrated circuit of claim 9, wherein said at least one pixel cell further comprises a charge collection region formed in said semiconductor substrate.

14. (Withdrawn) The integrated circuit of claim 13, wherein said at least one pixel cell further comprises a transfer transistor formed between said charge collection region and said photosensor.

15. (Withdrawn) An image processing system comprising:
a processor;
an imaging device coupled to said processor, said imaging device comprising an imaging array containing a plurality of pixel cells, at least one pixel cell comprising:

a semiconductor substrate having a halogen-rich region,

an isolation region within said halogen-rich region, and

a photosensor having a first doped region and a second doped region in association with said semiconductor substrate; and

readout circuitry within said semiconductor substrate, said readout circuitry providing signals from said photosensor.

16. (Currently amended) A pixel cell comprising:

a semiconductor substrate having trenches formed therein;

a photosensor formed in said substrate and having a first doped region and a second doped region in association with said semiconductor substrate, said photosensor being capable of generating dark current;

a halogen-rich region formed within at least one of said trenches ~~in a top surface of said substrate~~ for the suppression of said dark current; and

an isolation region formed within said at least one trench. ~~trenches of said semiconductor substrate.~~

17. (Original) The pixel cell of claim 16, wherein said halogen-rich region is formed with an ion selected from the group consisting of fluorine, chlorine, bromine, iodine, and any combination of fluorine, chlorine, bromine, and iodine.

18. (Previously presented) The pixel cell of claim 16, further comprising a charge collection region for receiving charges from said photosensor, said charge collection region being in association with said halogen-rich region and electrically connected to readout circuitry.

19. (Original) The pixel cell of claim 18, further comprising a transfer transistor in association with said halogen-rich region, and between said photosensor and said charge collection region.

20. (Original) The pixel cell of claim 19, further comprising a reset transistor formed in association with said halogen-rich region and electrically connected to said charge collection region.

21. (Withdrawn) An integrated circuit comprising

an array of pixel cells, at least one pixel cell of said array comprising:

a semiconductor substrate having at least one trench formed therein;

a halogenated low constant dielectric material formed within said at least one trench; and

a photosensor having a first doped region and a second doped region in association with said semiconductor substrate; and

signal processing circuitry formed in said semiconductor substrate and electrically connected to said array for receiving and processing pixel signals representing an image acquired by said array and for providing output data representing said image.

22. (Withdrawn) The integrated circuit of claim 21, wherein said halogenated low constant dielectric material is formed with an ion selected from the group consisting of fluorine, chlorine, bromine, iodine, and any combination of fluorine, chlorine, bromine, and iodine.

23. (Withdrawn) The integrated circuit of claim 21, wherein said halogenated low constant dielectric material is formed of fluorinated silicon oxide.

24. (Withdrawn) The integrated circuit of claim 21, wherein said halogenated low constant dielectric material is planar to a topmost surface of said semiconductor substrate.

25. (Withdrawn) A method of forming a pixel cell, said method comprising the acts of:

forming a trench in a semiconductor substrate;

forming a halogen-rich region localized at least at a sidewall region of said trench;

filling said trench with a dielectric material; and

forming a photosensor having a first doped region and a second doped region in association with said semiconductor substrate.

26. (Withdrawn) The method of claim 25, wherein said act of forming a halogen-rich region comprises doping said substrate with an ion selected from the group consisting of fluorine, chlorine, bromine, iodine, and any combination of fluorine, chlorine, and iodine.

27. (Withdrawn) The method of claim 26, wherein said act of doping said substrate is performed by ion implantation.

28. (Withdrawn) The method of claim 26, wherein said act of doping said substrate is performed by incorporating halogen through a high density plasma deposition process.

29. (Withdrawn) The method of claim 26, wherein said act of doping said substrate is performed by solid source diffusion of halogen ions.

30. (Withdrawn) The method of claim 25, wherein said halogen-rich region is formed at a depth of about 300Å to about 800Å from a surface of said semiconductor substrate.

31. (Withdrawn) The method of claim 25, wherein said halogen-rich region is formed having a concentration of halogen from about $5 \times 10^{13}/\text{cm}^3$ to about $5 \times 10^{15}/\text{cm}^3$.

32. (Withdrawn) The method of claim 25, wherein said first doped region of said photosensor is formed to overlap with said halogen-rich region.

33. (Withdrawn) The method of claim 25, further comprising the act of providing a mask over said semiconductor substrate before said step of forming said halogen-rich region.

34. (Withdrawn) The method of claim 25, further comprising the act of forming a charge collection region in said semiconductor substrate.

35. (Withdrawn) The method of claim 34, further comprising the act of forming a transfer transistor between said photosensor and said charge collection region.

36. (Withdrawn) A method of forming an integrated circuit, said method comprising:

forming an array of pixel cells, at least one pixel cell of said array being formed by:

forming a semiconductor substrate having at least one trench formed therein;

forming a halogen-rich region at least at a bottom portion and a sidewall region of said at least one trench; and

forming a photosensor having a first doped region and a second doped region in association with said semiconductor substrate; and

forming signal processing circuitry in said semiconductor substrate and electrically connected to said array for receiving and processing pixel signals

representing an image acquired by said array and for providing output data representing said image.

37. (Withdrawn) A method of forming an image processing system, said method comprising:

providing a processor;

forming an imaging device coupled to said processor, said imaging device comprising an imaging array containing a plurality of pixel cells, at least one pixel cell formed by:

forming a plurality of trenches in a semiconductor substrate,

forming a halogenated low constant dielectric material within each of said trench, and

forming a photosensor having a first doped region and second doped region in association with said semiconductor substrate; and

forming signal processing circuitry in said semiconductor substrate and electrically connected to said array for receiving and processing pixel signals representing an image acquired by said array and for providing output data representing said image.

38. (Withdrawn) The method of claim 37, wherein said halogenated dielectric layer is formed of fluorinated silicon oxide.

39. (Withdrawn) The method of claim 37, further comprising the step of planarizing said halogenated low constant dielectric material such that said halogenated low constant dielectric material is planar to a topmost surface of said semiconductor substrate.

40. (Previously presented) The pixel cell of claim 1, wherein said halogen-rich region is formed with fluorine.

41. (Previously presented) The pixel cell of claim 1, wherein said halogen-rich region has a substantially homogenous ion concentration to a depth of about 500Å from a surface of said substrate.

42. (Previously presented) The pixel cell of claim 16, wherein said halogen-rich region has a peak concentration at a depth of about 300Å to about 800Å from a surface of said substrate.

43. (Previously presented) The pixel cell of claim 16, wherein said halogen-rich region has a substantially homogenous ion concentration to a depth of about 500Å from a surface of said substrate.

44. (Currently amended) A pixel cell comprising:

a photosensor having a first doped region and a second doped region in association with a semiconductor substrate;

a shallow trench isolation region formed within said substrate and adjacent to said photosensor; and

a fluorine-rich region localized at a boundary between said shallow trench isolation region and said substrate. ~~least at a sidewall region of said shallow trench isolation region.~~

45. (Currently amended) A pixel cell comprising:

a photosensor having a first doped region and a second doped region in association with a semiconductor substrate;

a shallow trench isolation region formed within said substrate; and

a halogen-rich region localized throughout a surface of said substrate that contacts said shallow trench isolation region ~~at least at a sidewall region of said shallow trench isolation region~~ for suppressing the flow of dark current from said photosensor.

46. (Previously presented) The pixel cell of claim 45, wherein said halogen-rich region has a concentration of halogen ions from about $5 \times 10^{13}/\text{cm}^3$ to about $5 \times 10^{15}/\text{cm}^3$.

47. (Withdrawn) The pixel cell of claim 45, further comprising a charge collection region for receiving charges from said photosensor, said charge collection region being electrically connected to readout circuitry.

48. (Currently amended) A pixel cell comprising:

a photosensor having a first doped region and a second doped region in association with a semiconductor substrate;

an isolation region formed within a trench formed within said substrate;
and

a halogen-rich region localized within said trench ~~at least at a sidewall region of said isolation region~~ for suppressing the presence of charge collecting dangling bonds of said substrate at said trench. ~~the sidewall region.~~

49. (Previously presented) The pixel cell of claim 48, wherein said halogen-rich region is formed with an ion selected from the group consisting of fluorine, chlorine, bromine, iodine, and any combination of fluorine, chlorine, bromine, and iodine.

50. (Previously presented) The pixel cell of claim 48, wherein said halogen-rich region has a substantially homogenous ion concentration to a depth of about 500\AA from a surface of said substrate.